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WORLD INTELLECTUAL PROPERTY ORGANIZATION
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :
B29C 47/20, 47/86, 47/92
B29D 23/22

A1

(11) International Publication Number: WO 90/10530

(43) International Publication Date: 20 September 1990 (20.09.90)

(21) International Application Number: PCT/SE90/00154

(22) International Filing Date: 12 March 1990 (12.03.90)

(30) Priority data:
8900845-2 10 March 1989 (10.03.89) SE

(71) Applicant: UPONOR N.V. [NL/NL]; Emmaplein, Fouress Building, P.O. Box 259, Philipsburg, St. Maarten (AN).

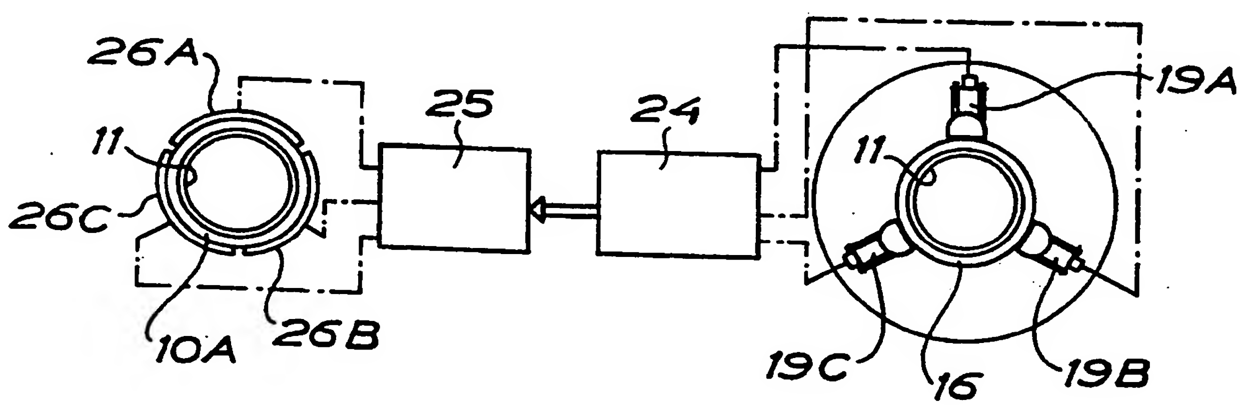
(72) Inventors: HÖLSÖ, Paul ; Bogrydsvägen 44, S-515 00 Viskafors (SE). UNTAMO, Ruohola ; Skarpåsdreven 34, S-523 00 Ulricehamn (SE).

(74) Agents: STRÖM, Tore et al.; Ström & Gulliksson AB, P.O. Box 4188, S-203 13 Malmö (SE).

(81) Designated States: AT (European patent), BE (European patent), CH (European patent), DE (European patent), DK (European patent), ES (European patent), FI, FR (European patent), GB (European patent), IT (European patent), LU (European patent), NL (European patent), NO, SE (European patent).

Published
With international search report.
In English translation (filed in Swedish).

(54) Title: METHOD FOR EXTRUDING A PLASTIC PIPE



(57) Abstract

Method for extruding plastic pipes from an extruder nozzle having a number of heating elements (26A, 26B, 26C) which are distributed circumferentially around the extruder nozzle (10A). The wall thickness of the extruded pipe is measured by means of ultrasound in a number of measuring positions (19A, 19B, 19C) distributed around the pipe, said measuring positions corresponding to the number of heating elements in the extruder nozzle and being located on the calibrator sleeve (16) in a vacuum or pressure calibrator (12) forming part of the extruder line. The power of the heating elements is controlled in dependence of measured thickness values for adjusting the surface friction and thus the wall thickness in the sections of the pipe wall, corresponding to the heating elements.

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METHOD FOR EXTRUDING A PLASTIC PIPE.

The invention relates to a method in extruding plastic pipes from an extruder nozzle having a number of heating elements distributed circumferentially around the extruder nozzle.

When plastic pipes are extruded, it is a quality requirement that the wall thickness of the finished pipe is within fixed tolerances. Therefore, the wall thickness is measured continuously during the extrusion, and the nozzle temperature is controlled in dependence on the effected measurement to adjust the wall thickness as is necessary in order to keep the thickness within the fixed tolerances. Today the wall thickness is commonly measured by means of an ultrasound sensor in or after the cooling device forming part of the extruder line, as disclosed in EP-A1-0153511 and EP-A1-0287551, the ultrasound sensor being moved continuously in a path around the pipe. Signals from the ultrasound sensor which represent the measured wall thickness are forwarded via a microprocessor to control means for adjustment of the heat power of the heating elements of the extruder nozzle. The number of heating elements usually is three, and thus, each heating element covers one third of the pipe circumference. If the ultrasound sensor generates a signal which indicates that the wall thickness is too small in that third of the pipe circumference which corresponds to a certain heating element, the power of this heating element will be increased in order that the plastic material in said sector of the nozzle, which is heated by the heating element will have reduced friction against the wall of the nozzle passage and thus the wall thickness in said sector will be in-

creased. Reversely, the heat power will be decreased if the wall thickness is found to be too large. Since the position where the measurement takes place is located at a great distance from the extruder - there may be a distance of 15 to 20 m - the response in the adjustment will be slow because it takes long time before the portion of the pipe which is delivered from the extruder nozzle after adjustment of the heat power, reaches the position of measurement, and thus, it takes long time before the control system indicates and adjusts an existing deviation, if any. However, also for another reason the location of the position of measurement is unsatisfactory. When the pipe has passed through part of the cooling device it has already a skin on the outside as well as the inside thereof because it has been cooled initially in the calibrator disposed immediately after the extruder nozzle, and then in the cooling device wherein the pipe is sprayed with water from nozzles disposed above the pipe. Due to cooling of the pipe in this manner in the cooling device the plastic material of the pipe will not have a uniform temperature between the skins over the total circumference of the pipe. The temperature is lower in the upper portion than in the lower portion of the pipe. Since the wall thickness measurement as effected by means of ultrasound is dependent on the temperature of the material, the measurement and the control cannot be effected with the desired accuracy. It follows that an ample wall thickness is maintained in order that the wall thickness will not come below the lower tolerance value. Considering the fact that the material cost comprises about 75% of the total manufacturing cost of the pipe, this involves an additional cost in the manufacture,

which is not insignificant. The most economical procedure is of course to maintain the wall thickness as close to the lower tolerance value as possible without the risk of coming below this value.

In addition to this the device for driving the ultrasound sensor in a path around the plastic pipe is complicated and will easily be exposed to operational disturbances, and the measuring and control system is difficult to adjust initially.

Despite the obvious drawbacks of the existing measuring and control system no other, better system has been proposed so far.

The invention has been proposed for the purpose to provide a more accurate and reliable measurement and control by means of simpler and more dependable equipment.

Thus, the invention provides a method in extruding plastic pipes from an extruder nozzle having a number of heating elements which are distributed circumferentially around the extruder nozzle, the wall thickness of the extruded pipe being measured by means of ultrasound in a number of measuring positions distributed over the circumference of the pipe, which corresponds to the number of heating elements of the extruder nozzle, and the power of the heating elements being controlled in dependence on the measured thickness values for control of the friction and thus the wall thickness in the sectors of the pipe wall corresponding to the heating elements, and this method for the related purpose has obtained the characterizing features of claim 1.

So far, it has not been considered suitable or even possible to locate the positions of measurement to the calibrator because the calibrator is a relatively complicated apparatus in the extruder

line, either it is of the vacuum type or of the pressure type, due to the fact that the calibrator comprises a number of valves and pumps for air and cooling water. Also, it has not so far been understood that advantages could be gained by such arrangement. On the contrary the common apprehension was that modifications in the calibrator could lead to operation and quality disturbances. Now, when the measurement according to the method of the invention nevertheless takes place in the calibrator contrary to that considered suitable or possible, it has been found that there is obtained a considerably more accurate control of the wall thickness without jeopardizing the function of the extruder line in any respect. This would primarily be due to the fact that the material of the pipe wall when passing through the calibrating sleeve still has a rather homogenous temperature condition around the circumference of the pipe because the pipe having left the extruder has not yet been cooled with accompanying temperature differences in the pipe material, so that the thickness can be reliably measured in the measuring positions, but also is due to the fact that the response in the control will be faster because the measuring positions are considerably closer to the extruder nozzle, maximum about 0.5 m therefrom.

In order to explain the invention in more detail reference is made to the accompanying drawings in which

FIG. 1 is a side view of an extruder line,

FIG. 2 is a half-side view and a half axial cross sectional view of the calibrating sleeve in a calibrator of the vacuum type, provided with ultrasound sensors, and

FIG. 3 is a diagram showing the connection of the sensors to the heating elements of the extruder nozzle via a microprocessor.

In FIG. 1 there is shown an extruder line for extruding pipes in the simplest form thereof. The extruder is fragmentarily shown at 10, and from the nozzle 10A thereof (forming part of the extruder tool) a pipe 11 is being extruded, which passes through a calibrator 12 and then through a cooling trough 13 to a take-away device 14. In the measuring and control system applied today and described above the ultrasound sensor is located at the position indicated by an arrow 15 at the outlet end of the cooling trough.

When the method of the invention is supplied there is used in one embodiment three stationarily arranged ultrasound sensors located inside the calibrator. In FIG. 2 the calibrator sleeve 16 of a calibrator of the vacuum type is shown, and this sleeve in a known manner forms a number of through slots 17 connecting the inside of the sleeve with a vacuum chamber 18 enclosing the sleeve. The plastic pipe 11 comes from the extruder nozzle and passes into the left end of the calibrator sleeve the pipe being sucked against the inside of the sleeve under the influence of the vacuum to be calibrated against the sleeve. At the outlet end of the sleeve, the right end as seen in the figure, there should be provided three ultrasound sensors 19A, 19B and 19C spaced 120° as shown diagrammatically in FIG. 3, but for the sake of simplicity only two of the sensors are shown in FIG. 2, namely 19A and 19B. Each sensor is mounted in a holder 20 on a ring 21 which is attached to the outside of the calibrator sleeve 16 a passage 22 being provided from the sensor

through the holder, the ring and the sleeve to the pipe passing through the sleeve, said passage being filled with water supplied at a nipple 23 and serving as transmission medium for the ultrasound between the sensor and the pipe.

In FIG. 3 it is shown that the three ultrasound sensors 19A, 19B and 19C are connected to a microprocessor 24 which controls over control means 25 (confer also FIG. 1) three electric heating elements 26A, 26B and 26C which are provided in the extruder nozzle 10A and extend each over about one third of the circumference of the nozzle. The three sensors are fixedly mounted centrally one in each of the sectors of the circumference of the pipe, which correspond to the three heating elements, and each sensor is adapted to control via the microprocessor and the control means the associated heating element.

When the extruder line is operating each sensor thus measures the thickness of the pipe 11 in the corresponding measuring position on the pipe, and this signal is forwarded to the microprocessor wherein the signal is compared with signals which represent programmed limit values one of which represents the lower tolerance value of the wall thickness of the pipe and the other one represents the upper tolerance value or preferably a value of the wall thickness which is closer to the lower tolerance value. If the signal from the sensor is below or above the lower and the upper limit value, respectively, the microprocessor gives a control signal to the control means for the associated heating element in order that the power thereof will be increased or decreased, respectively, so that the surface friction between the material and the wall of the nozzle passage in the sector of the nozzle

which is heated by said heating element, will decrease or increase, respectively, the wall thickness of the pipe being increased or decreased, respectively, in said sector as a consequence thereof. The response in the control is rapid because the distance between the sensor and the heating element is relatively small.

Three sensors have been found to be a suitable number of sensors for pipes up to 200 mm diameter but for larger pipes a larger number of sensors can be provided.

In another embodiment of the method of the invention the sensors are mounted for movement circumferentially the sensors being moved back and forth over the associated sector of of the pipe and a mean value of the thickness values measured in the sector is calculated in the microprocessor. The mean value then is used for controlling the power of the associated heating element as described above.

CLAIMS

1. Method in extruding plastic pipes (11) from an extruder nozzle (10A) having a number of heating elements (26A, 26B, 26C) which are distributed circumferentially around the extruder nozzle, the wall thickness of the extruded pipe being measured by means of ultrasound in a number of measuring positions (19A, 19B, 19C) distributed over the circumference of the pipe, which corresponds to the number of heating elements of the extruder nozzle, and the power of the heating elements being controlled in dependence on the measured thickness values for control of the friction and thus the wall thickness in the sectors of the pipe wall characterized in that the wall thickness is measured in measuring positions (19A, 19B, 19C) on the calibrator sleeve (16) in a vacuum or pressure calibrator (12) forming part of the extruder line.

2. Method as in claim 1 wherein the measurement takes place in fixed measuring positions.

3. Method as in claim 1 wherein the measuring positions are moved back and forth circumferentially over the sector of the pipe which corresponds to the associated heating element, and that the control is effected in dependence on a calculated mean value of the wall thickness within the sector.

4. Method as in any of claims 1 to 3 wherein the measurement is effected at the outlet end of the calibrator sleeve (16).

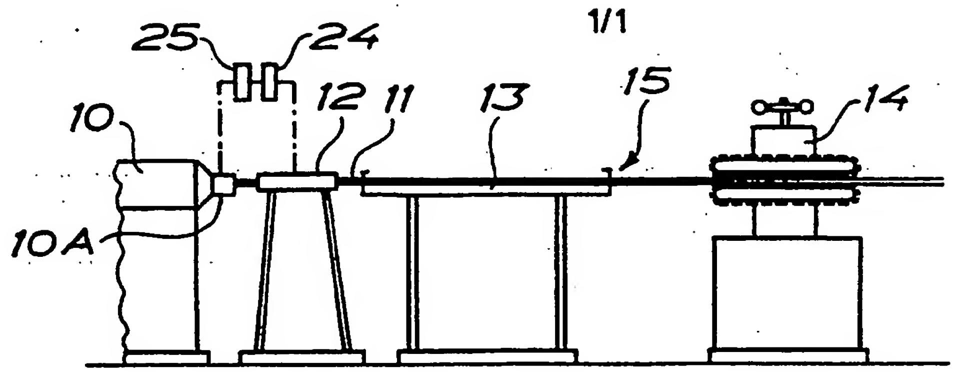

FIG. 1

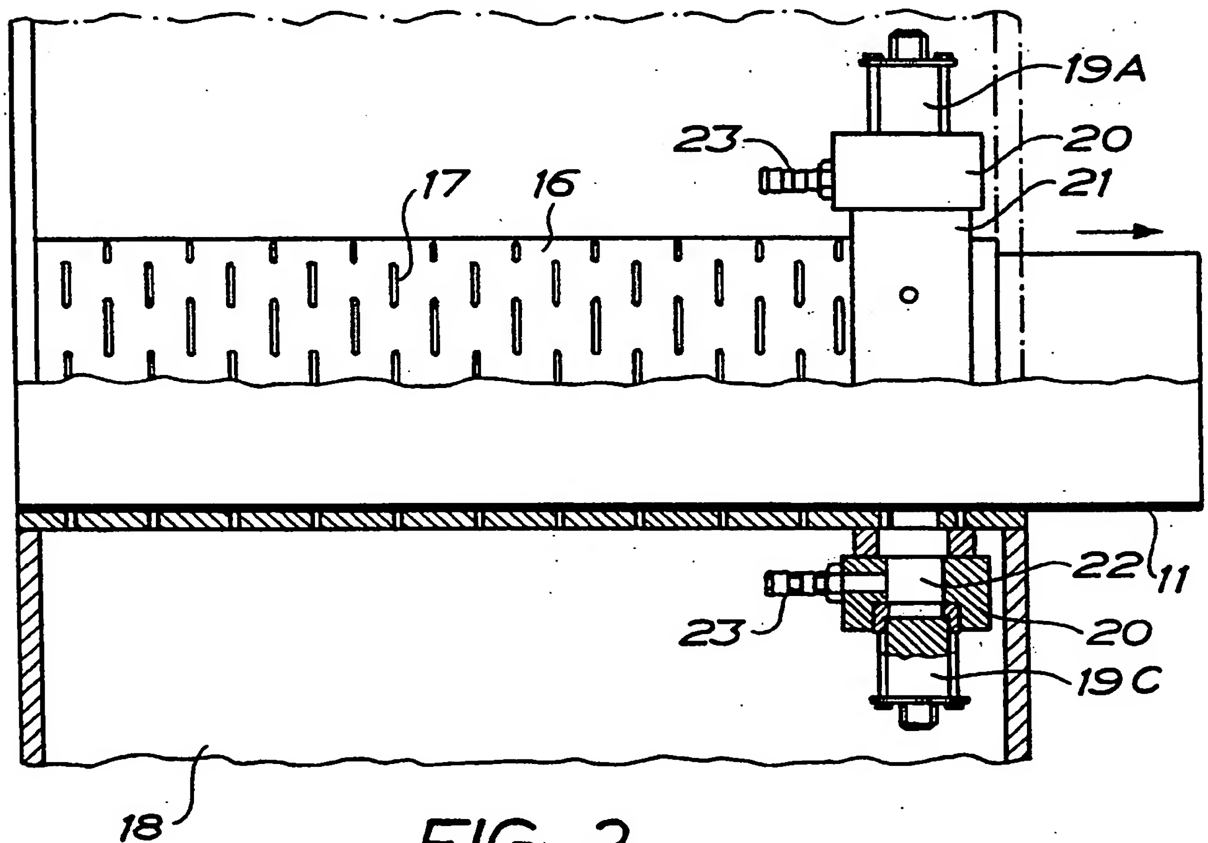

FIG. 2

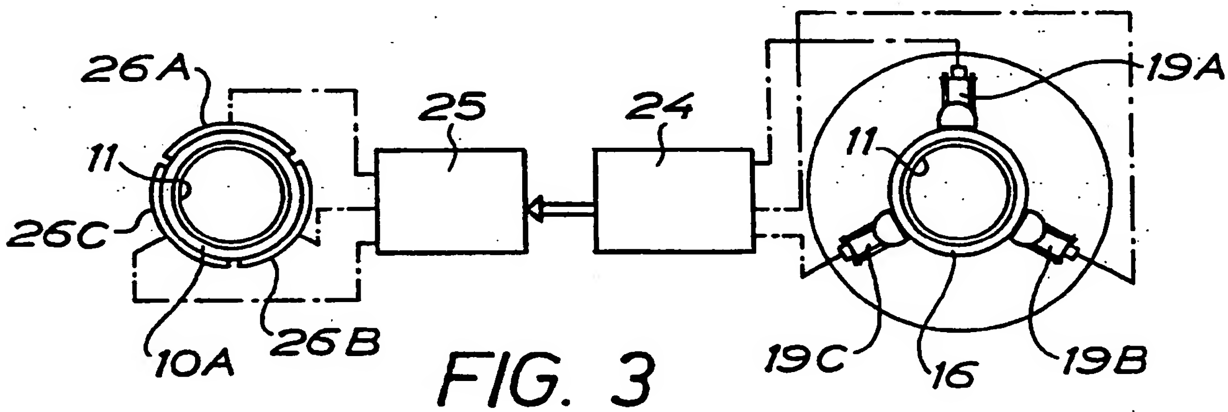

FIG. 3

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 90/00154

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 29 C 47/20, /86, /92, B 29 D 23/22

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	B 29 C; B 29 D

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No.[13]
Y	EP, A1, 0153511 (WAVIN B.V.) 4 September 1985, see page 3, line 17 - page 4, line 6; page 8, line 23 - page 9, line 6; page 10, line 20 - page 11, line 9 --	1-4
Y	EP, A1, 0287551 (CINCINNATI MILACRON INC.) 19 October 1988, see column 2, line 25 - column 3, line 3; column 4, line 40 - line 53; claim 1 --	1-4
Y	US, A, 4137025 (GRAVES ET AL) 30 January 1979, see column 2, line 65 - column 3, line 38; column 4, line 24 - line 32; column 5, line 11 - line 68; claim 1 --	1-4

* Special categories of cited documents: [10]

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
13th June 1990	1990 -06- 14
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Jan Nilsson

Form PCT/ISA/210 (second sheet) (January 1985)

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category *	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No
Y	US, A, 4740146 (ANGELBECK) 26 April 1988, see claim 13 --	1-4

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 90/00154

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 90-05-07
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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP-A1- 0153511	85-09-04	CA-A-	1250119	89-02-21
		DE-A-	3472919	88-09-01
		JP-A-	60178019	85-09-12
		NL-A-	8304451	85-07-16
		US-A-	4749531	88-06-07
		US-A-	4793788	88-12-27
		US-A-	4886438	89-12-12
EP-A1- 0287551	88-10-19	AU-D-	1381988	88-10-06
		JP-A-	63272519	88-11-10
		US-A-	4882104	89-11-21
US-A- 4137025	79-01-30	US-A-	4152380	79-05-01
US-A- 4740146	88-04-26	NONE		